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ABSTRACT

The United States Federal Government has been conducting guaranteed savings energy savings performance contracts for over 20 years and now relies on ESPC for the majority of its energy efficiency work. Along with a related financed project type, these deals resulted in $4.2 billion of project investment in the five years ending in 2016, a pace that has even accelerated since.

Measurement and verification (M&V) on the projects is the key to assuring savings realization and persistence. Perceived as a weakness or burdensome added cost in the early years of the program, M&V has become a strength. All energy conservation measures (ECMs) have some form of measurement – defined as a measured baseline establishment followed by at least one measurement of the main energy-saving parameter taken in the performance period for each ECM. The government's in-house energy consulting office, the Federal Energy Management Program (FEMP), now recommends measurement of these "Option A" M&V ECMs throughout the contract term, usually annually. Moreover, a significantly higher percentage of projects are now characterized by more ambitious M&V, including Option B (all parameter measurement) for most generation (including renewable) and some efficiency measures, and more frequent Option C (whole facility utility bill analysis) for "deep retrofit" projects with multiple, interactive ECMs. Coincident with this progress in M&V has been a much greater embracing of ESPC by the federal agencies, resulting in the enormous rate of projects now executed.

This paper traces the evolution of M&V in federal ESPC and argues that the heightened credibility of the savings has contributed significantly to the procurement vehicle's long-term viability. This focus on savings integrity via M&V has been learned over two decades for U.S. federal ESPC, but countries with developing ESPC markets would be wise to emphasize it as their markets emerge, allowing them to avoid some of the "growing pains" experienced in the U.S.

Keywords**—**energy savings performance contracting (ESPC or EPC), energy service companies (ESCOs), measurement and verification (M&V)

ESPC'S HISTORY IN THE U.S.

Energy savings performance contracting (ESPC) has a now 40-year history in the United States. Not surprisingly, it has evolved considerably. The ESPCs of the late 1970s and early 1980s were conducted using "shared savings" approaches, in which the energy service company (ESCO) would generally borrow the money and install energy conservation measures (ECMs) at a facility for no up-front cost. The ESCO would then be paid a proportion of the energy bill savings that ensued over the years of the contract (with the customer retaining the other portion). Shared savings is a simple and intuitively desirable business model, but it had two key flaws that became exposed over time. The first is that it involves a transfer of energy price risk from the customer to the ESCO for the energy being saved in a deal. This meant that once energy prices fell – as they did in the U.S. in the late 1980s – many of the deals fell short of their expected savings, jeopardizing not only the ESCOs' returns but their credit (Hansen, 2009).

A second problem with the shared savings model is more nuanced. Since the energy bill was the ultimate arbiter of the savings achieved, the units of energy saved (along with their price) was what ESCOs were relying on to make their returns. This is ostensibly very sensible, because it put the performance risk on the ESCOs' shoulders. However, it also saddled those same ESCOs with the risk that their customers might add floor space, hours, employees, or customers (think of hotels, for instance), or produce more of their product, all of which tend to drive up energy usage. At its core, the associated challenge is one of measurement and verification (M&V) of the savings: how it's conducted (e.g., via the bill or in some other manner), how to account for changes at the facility outside of the ESCO's control, and, at the broadest level, how risk is divided between the customer and ESCO. Though the term had not yet been coined, these pioneering shared savings ESPC projects were employing "Option C" M&V – also known as utility bill analysis. Option C (one of four key options that are described below) is the most intuitive of M&V methods: compare the whole facility consumption before and after the intervention.

While Option C M&V often includes provisions for weather adjustments (usually based on regression analysis with heating or cooling degree days), there are a lot of other factors that can affect utility bills and they are generally difficult to account for because they may not have occurred before at the facility (consider staffing increases or space additions, for instance). This deems the magnitude of their future impact difficult to gauge. Moreover, it is also the case that ESCO-installed equipment might not be operated and maintained properly by the customer. For these reasons, these early ESPCs resulted not uncommonly in conflict (including lawsuits) between ESCOs and their customers (Hansen, 2009; Shonder and Avina, 2016).

EMERGENCE OF FORMAL M&V AND GUARANTEED SAVINGS

To help resolve this problem and generally regain credibility for the industry, two key changes ensued. The first was the mid-1990s development, primarily supported by the U.S. Department of Energy, of an objective guideline for how to conduct M&V. This effort, originally dubbed the North American Measurement and Verification Protocol (NEMVP) and later re-named the International Measurement and Verification Protocol (IPMVP), outlined four "options" – Options A, B, C, and D – by which ECMs could be measured and their savings verified. The first two (A and B) involve a "retrofit isolation" approach, in which the ECM's effects are measured in isolation, divorced from other impacts in the facility (e.g., portable power meters are used to gauge the power draw from the lights before and after the lighting change-out, and light loggers measure the hours of operation before and after the vacancy sensors' installation). Option A involves measurement of just the "key" parameter, whereas Option B directs measurement of all relevant parameters (sometimes involving a dedicated meter). Retrofit isolation can be a very effective way to measure savings, especially when an ECM's effects are not complex nor highly interactive with other ECMs.

A second important change in the industry was the move away from the shared savings model and toward a new concept called "guaranteed savings," in which the ESCO would commit to its performance – i.e., delivering a given amount of energy savings – but leave the energy price risk with the customer. Expected or conservative energy pricing was projected and included in the deals, but only to demonstrate that the guaranteed energy savings would translate into sufficient money savings to cover the payments on the financing. The latter was more and more commonly arranged by the (usually public sector) customer, rather than the ESCO, in various forms including direct loans but also general obligation bonds and various lease arrangements with the ESCO or equipment supplier (Hansen, 2009).

Together with the rise of the guaranteed savings model came a shifting reliance in M&V on Options A (retrofit isolation, with the key parameter measured) for simpler ECMs and, for more complex ones, Option D, which involves a computer simulation of the affected building(s), with and without the retrofits installed (Shonder and Avina, 2016). These M&V methods largely insulate ESCOs from factors like space additions, occupancy changes, O&M negligence, or even just unspecified "load creep." This is particularly the case when the post-installation savings measurements are made only once, just prior to project acceptance, and then stipulated as constant for the remainder of the term, as was often the case (Shonder and Avina, 2016). While this shift was in one sense a plus for the industry, ridding ESCOs of risk for variables they did not control, it also served to distance these ESPCs from the appeal of the original shared-savings model, in which the utility bill (even leaving out unit prices for energy) was the determinant of the project's performance. Utility bills come from largely dependable and disinterested third parties to the deal, not to mention their expression in currency, rather than more esoteric energy units like kWh and Btus. This understandably makes them easier to grasp, particularly for non-engineers engaged in the ESPC negotiations.

Consequently, the new generation of ESPCs, using guaranteed savings and limited M&V, and largely insulating ESCOs from performance (not to mention price) risk, lost some of their original appeal (Shonder and Avina, 2016). One testament to this is that even today (2019), many customers still insist on Option C M&V, even though virtually all ESPCs in the U.S. are now guaranteed savings deals. On the other hand, customers in the non-federal market have increasingly taken to terminating their performance period deals with their ESCOs after two to five years, citing their confidence that the savings are being achieved or – consistent with the thesis that the absence of measurements during the performance period deemed the M&V less worthwhile – that they did not see sufficient value in the ongoing M&V (Gilligan, 2017).

ESPC IN THE U.S. FEDERAL GOVERNMENT

Guaranteed savings ESPCs were authorized for U.S. federal government facilities with the passage of the Energy Policy Act of 1992, and started gaining momentum in the government following a subsequent (1995) DOE rule and the creation in 1998 of "indefinite delivery, indefinite quantity" (IDIQ) contracts by the Department of Energy and the U.S. Army Corps of Engineers. The number and dollar volume of the projects have vacillated over the years, but have reached unprecedented levels in the last four years (2016 to 2019), with nearly a billion dollars of investment annually by ESCOs working in the federal sector.[1]

While use of ESPCs was permanently authorized in 2007 (prior authorizations had been only temporary), use of the vehicles was inconsistent both across and even within federal agencies, with some agencies at times turning away from them altogether for a matter of years. Project volume started accelerating in 2012, with $4.2 billion being executed in the five-year span between 2012 and 2016, the period of a "Presidential Performance Contracting Challenge" (PPCC) from President Obama. But even in the absence of a similar push from the Trump administration, the high volume from the PPCC has continued in the last three years. And of the six agencies who have made the most use of ESPCs, all have been very active over the last three years for which complete data are available (2016-2018), with between 7 and 33 awarded projects and between roughly a quarter and a half billion dollars of project investment per agency (over the three-year span). In contrast, over the 21 years since the inception of the IDIQs, four of those six agencies had at least one three-year period in which they awarded either zero (three of the four agencies) or one project per year (the fourth agency).

What explains this seeming souring – or at minimum, loss of interest – toward ESPC by these agencies and their subsequent return to active use of the vehicle? There are several factors, from agency procurement policies that made use of ESPCs unattractive for eligible ESCOs to concerns about ESCO pricing of the deals. However, in interviews with long-time ESPC leaders at the four agencies that had the long hiatuses from ESPC, two brought up concerns about M&V and the legitimacy of the savings guarantees in explaining why his or her agency had ceased, or nearly ceased, its ESPC activity for years at a time.

In contrast, each of these representatives also shared that their agency, in resuming ESPC activity, put an increased emphasis on M&V and savings integrity. For instance, one of the agencies now requires that 70% of the savings in its ESPCs use metered M&V, i.e., IPMVP Options B (retrofit isolation, all parameter measurement) or C (whole facility utility bill analysis) (Allison, 2018). Another strongly pushes the ESCOs working with it to adhere to a set of recommended M&V outlines (originally developed for the agency itself and now incorporated by DOE's Federal Energy Management Program, FEMP, in its M&V guideline document) covering 19 of the most popular ECMs (Spader, 2019). Perhaps not coincidentally, all of these agencies have transitioned their ESPC activities to a single, central office commissioned by headquarters, rather than having the individual projects led by personnel at the customer sites themselves.

INCREASED M&V RIGOR VIA FEMP GUIDELINES

Concurrent with individual federal agencies' push for more rigorous M&V has been a tightening of the government's recommended M&V practices, as authored by FEMP. FEMP first published its guidelines in 1996, just after the 1995 publication of DOE's rule on ESPC and shortly before the signing of its first indefinite delivery, indefinite quantity (IDIQ) contracts with ESCOs in 1998. The document was updated in 2000 as *M&V Guidelines: Measurement and Verification for Federal Energy Projects (Version*

[1] See, for instance, the annual list of projects under DOE's IDIQ at https://www.energy.gov/eere/femp/downloads/doe-idiq-energy-savings-performance-contract-awarded-projects.

2.2). Version 2.2 stated explicitly that it was an "application of the IPMVP to federal projects." Nonetheless, in contrast to the contemporaneous version of the IPMVP, Version 2.2 permitted "stipulation" of all savings variables – i.e., it required *no* measurement whatsoever – for its rendition of Option A for three common ECMs: chillers, lighting, and water conservation from retrofitted plumbing fixtures.

Versions 3.0 (2008) and 4.0 (2015) of the guidelines made Option A M&V progressively more rigorous. Version 3 dispensed with allowing "pure stipulation," requiring – consistent with the IPMVP – that all Option A M&V always include both pre- and post-retrofit measurement of an ECM's key parameter. Version 4 took that a step further, making the default condition that measurement of the key parameter occur *annually* during the performance period, as opposed to the common practice of just one or two measurements (the first, and often only, one taking place during the post-installation inspection). Exceptions are permitted, especially for simple and reliable ECMs like one-for-one lighting retrofits.

In addition to fortifying Option A, Version 4 made a couple of other significant strides towards improving rigor. One small step involved Option C, which has not been widely used in federal ESPC traditionally. Version 4 made clear that an obstacle to the use of Option C, one that is prominent in the eyes of ESCOs, is that facilities' use profiles – including their occupancy, hours of operation, activities (think of office space that becomes an exercise center), plug loads, etc. – almost inevitably changes over time, sometimes substantially. Consequently, ESPCs that use Option C in these buildings subject their ESCOs to risks that the ESCOs generally have no control over. Version 4 emphasizes that where Option C is used – and it is sometimes a very defensible choice when multiple interactive ECMs are being deployed, and savings are high – it may make sense to use Option C only in the first two or three years of performance, after which a switch to different options (generally the retrofit isolation options, A and B) is a sensible approach. In other words, prove to us that the very large savings are being achieved, after which we understand that our facility "noise" may obfuscate things and we'll accept "lesser" (retrofit-specific) proof that guaranteed performance is being achieved.

The most conspicuous difference between Version 4 and its predecessors was the unprecedented move to include a new section of the guidelines that identifies, for 19 common ECMs, what its authors consider to be good practice M&V. A whole chapter is devoted to providing short (one- to two-page) outlines of recommended M&V plans, each associated with a specific IPMVP option (i.e., A, B, C, or D). This may not seem monumental, but it was unprecedented for either the FEMP guidelines to be anything other than agnostic about M&V option choice. FEMP now routinely trains federal audiences to query their ESCOs in instances where the recommended options (and associated plans) are not being employed for ECMs that are covered by the guidelines' plan outlines.

TREND AWAY FROM OPTION A AND TOWARDS METERED M&V (OPTIONS B AND C)

Consistent with the aforementioned effort by the agencies to inject greater rigor into their ESPCs' M&V have been programmatic M&V trends over the two decades. FEMP has tracked the M&V used for all ECMs under ESPC projects using its IDIQ[2]. The results, tabulated both in terms of the frequency and dollar volume of options employed, support the thesis of increasing rigor.

The most telling contrasts are from the first ten years of awards (1999-2008) compared with the most recent four (2016-2019), i.e., the period subsequent to the release of Version 4.0 of FEMP's M&V guidelines. Per Figure 1, the proportions of ECMs, as well as dollar investment, using Option A has declined considerably, from 75.1% of ECMs representing 70.2% of project investment in the first decade of the program to 64.2% of ECMs and just 46.2% of investment in the 2016-2019[3] span. Compensating for this decline, ECMs using Options B and C were just 18.2% of the total count, representing 22.9% of investment in the 1999-2008 period. In contrast,

[2] What FEMP tracks is the "first year" M&V, i.e., the M&V option employed in the first year of performance following acceptance. There are instances when the initial M&V transitions (usually to a less rigorous option, e.g., from C to A) after the first two or three years of project performance.

[3] The 2019 numbers presented here extend only through mid-September, 2019 because of the timing of this manuscript.

34.7% of ECMs and a majority 52.5% of project investment utilized Options B and C from 2016 to 2019.

Table 1. ECMs' use of Option A versus Options B and C – early years and recent history.

Per-iod	**Option A (#)**	**Option A ($)**	**Option B/C (#)**	**Option B/C ($)**
1999 - 2008	528/703 **(75.1%)**	$94.1M **(70.2%)**	128/703 **(18.2%)**	$22.0M **(22.9%)**
2016 - 2019	233/363 **(64.2%)**	$70.9M **(46.2%)**	126/363 **(34.7%)**	$80.6M **(52.5%)**

This trend underscores the gravitation towards greater rigor that the agencies appeared to be pursuing, echoing the interview comments from several of the major ESPC users. It is particularly noteworthy in light of the fact that, as mentioned above, FEMP's application guidance for these projects actually made Option A notably *more* rigorous in 2008 and then further again in 2015.

While the greater rigor is indirectly reflected in the agencies' greater confidence (i.e., higher investment) in ESPCs, it can also be seen more directly in progressively increasing reports of achieved savings from the deals. The most recent results from active projects using FEMP's IDIQ, of which there were 185, report savings realization at 108% (105% considering "government impacts" to savings) of the guarantees (Walker, 2019). While these are ESCO-reported figures, the fact that the percentage is at a 21-year programmatic high amidst progressively tighter M&V (not to mention increasing emphasis on agencies "witnessing" the ESCOs' M&V activities) is telling.

CONCLUSION

In two decades of doing guaranteed savings ESPCs, the U.S. federal government has learned a great deal; the market and its customers have matured. One key facet of that learning has revolved around the way M&V is executed for federal projects. Where rigor was questionable, both as enforced by the customer agencies and also codified by FEMP (their in-house consultant for ESPC), it has evolved. This is evident in the tightening of the government's own guidelines for M&V – in the form of FEMP's setting a progressively higher bar for the minimum acceptable form of M&V (Option A), as well as in providing recommended options and skeleton plans for different ECMs. The evolution is also apparent in the agencies' trend away from reliance on Option A (its increased rigor notwithstanding) over time. Lastly, those same agencies stated commitments to strive for greater savings integrity in their projects, while merely anecdotal, is reinforced by their obviously increased faith in ESPC as an energy savings (and infrastructure renewal) tool: federal ESPC volume is at an unprecedented level of nearly a billion dollars of investment per year, and all six of the agencies who have used ESPC most actively over the past two decades are now tapping it at higher rates than ever before.

So what does the U.S. government's ESPC experience have to offer to other entities (including countries) pursuing ESPC programs? There are numerous lessons learned. Some – like the advantages of developing central centers of expertise to execute the deals, rather than training individual site teams one after another – don't necessarily, or at least primarily, have to do with M&V. However, several key lessons very much revolve around M&V. All of them can be distilled down to one key point: push for savings integrity, both in individual deals and the policy guidance that underlies them. While the cost of M&V is legitimately viewed as parasitic on the deals, since it costs money and doesn't offer additional savings, *per se*, this cost (which in the U.S. federal program averages less than 3% per year of the projects' savings) seems trivial when viewed in light of the confidence it appears to confer:. Where in the first decade or so of their availability, agencies' use of the vehicles was marked by start-and-stop intervals, the recent pattern has been sustained very high ESPC investment. The central theme underlying this heavy reliance on the projects is obvious: confidence in these vehicles' meeting their expectations – particularly regarding their realization and persistence of savings – is essential to their enduring use.

ESPC is a very powerful tool, with enormous potential for achieving energy savings, due to its appealing public-private partnership aspect and "paid from savings" financing. Countries with emerging ESPC markets would be wise to heed the lessons learned from those with more mature markets. The importance of savings integrity in ESPCs – particularly, the belief that the projects are performing as claimed (i.e., generating and maintaining their savings) – is crucial to customers sustained use of the vehicle.

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